Metro electrification system 1,5KV - rigid catenary

ENVIRONMENTAL PRODUCT DECLARATION

EPD®
THE INTERNATIONAL EPD® SYSTEM

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ALSTOM
Designing fluidity

CONTENTS

Edito

ALSTOM, AT THE FOREFRONT OF SUSTAINABLE MOBILITY

As a promoter of sustainable mobility, Alstom places environmental issues at the heart of its R&D strategy, constantly designing solutions and products which are less energy-consuming, quicker to install, cheaper to maintain, and with higher lifespan and reduced carbon footprint.

For more than 10 years, the company has systematically introduced eco-design in its engineering procedures. Various environmental dashboards have been implemented. They help us to quantify and improve the environmental impact of our solutions from development phase up to final use. Today, Alstom can rely on a team of more than 100 eco-experts to ensure the environmental performance of its portfolio and is able to develop innovative infrastructure solutions tackling key environmental challenges. Alstom is deploying these eco-design tools to rail infrastructure.

Metro electrification in 1.5 kV with rigid catenary

Alstom has assessed the environmental footprint of a metro electrification system in 1.5 kV and with our in-house rigid catenary solution. This is a key achievement allowing us to monitor and improve the sustainability of our electrification systems.

Eric Marie
VP Systems & Infrastructure Platforms

SUSTAINABLE MOBILITY

Alstom, at the forefront of sustainable mobility

Alstom develops and offers a range of systems, equipment and services for the rail sector and considers its mission to support the transition towards global sustainable transport systems that are inclusive, environmentally-friendly, safe and efficient. As well as taking the life cycle into account, from concept to recycling including maintenance and energy consumption, Alstom offers innovative solutions that respect the environment and meet the mobility needs according to a socially responsible model. As a major player in ecological transport, sustainable development is at the heart of the Alstom's strategy.

Alstom has a an environmental management system fully in place and 100% of manufacturing sites and regional centers over 200 employees are certified according ISO14001.

Ecodesign approach

More than 10 years ago, Alstom systematically introduced eco-design in to its engineering procedures for that very purpose. It has given rise to environmental dashboards that focus on fundamental topics at the start of the development phase, the quantification of the environmental impact (life cycle assessments) and more ecological solutions. Today, more than 100 experts (eco-designers, experts for acoustic and energy-saving materials) endeavor to ensure the environmental performance of each solution.

Ecodesign approach addresses the design and development of products using a life cycle perspective. It aims at continually improving the environmental performance of products through the management of their significant environmental aspects. In this context, life cycle assessment (LCA) is a relevant tool to identify and thus to allow the reduction of products' environmental impacts.

Electrification solutions

Alstom electrification portfolio encompasses feeding systems and power supply systems adapted to each type of rolling stocks such as tramway, metro and main lines. It covers all infrastructure needs from new lines to extension, refurbishment and maintenance projects. Active in-house innovation programs on infrastructure products and solutions aims at improving urban insertion and construction time as well as energy efficiency, carbon footprint and overall performance. Energy consumption is a key driver of environmental impacts for railway transport service therefore electrification solutions have a high role to play to limit and improve the overall environmental performance of railway systems.

See Alstom's annual registration document for more information on Alstom Sustainable Development Strategy, including eco-design on www.alstom.com

DESCRIPTION OF THE PRODUCT

This environmental declaration covers a typical metro electrification system of 1,5kV with Overhead Rigid Catenary System (ORCS).

This electrification solution encompasses all the equipment and materials required to feed metro trains from the connection to the local electricity supplier.

MAIN CHARACTERISTICS

Type of transport:
Metro

Type of current:
1500 V DC, 50 Hz

Total length of double passengers' line:
16 km

100% tunnel monotube

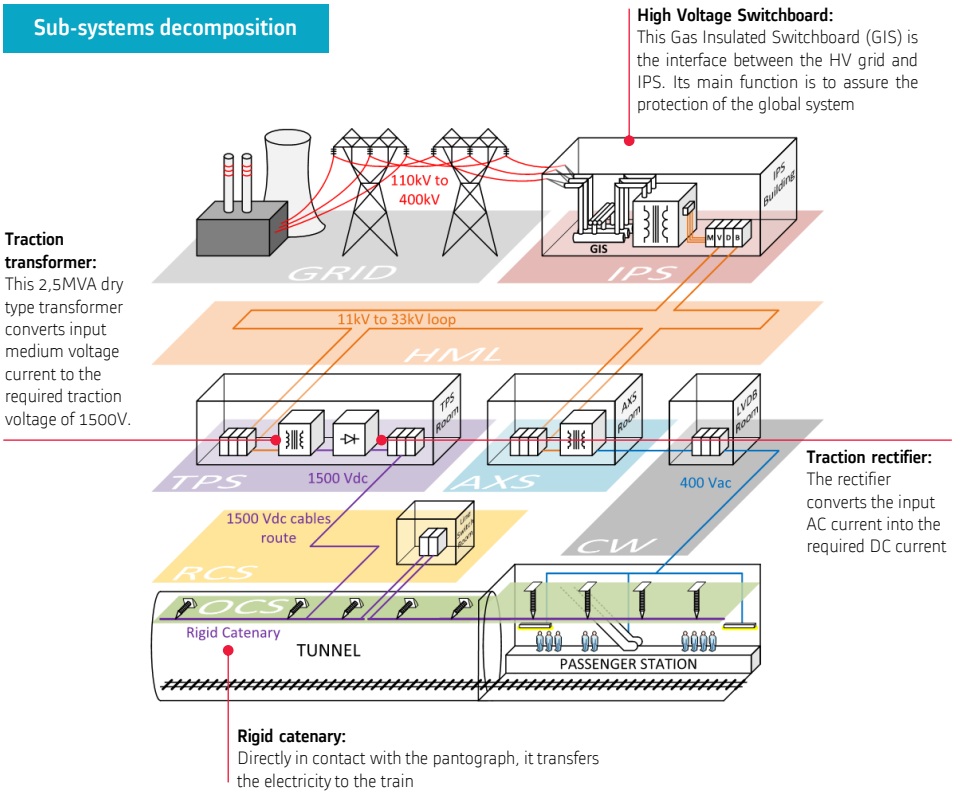
Total length of single track 40 km:
line & depot

Quantity of passengers' stations:
12

Design speed:
80km/h

Lifetime:
20 years

Sub-systems decomposition



Intake Power Substation:
It transforms the AC voltage from the local energy supplier into the voltage needed by HV and/or MV networks.

High and Medium Voltage Line:
It collects the primary current from the IPS or local energy supplier and distributes it to the medium voltage switchboard of the TPS and of the AXS.

Traction Power Substations:
It converts the primary energy coming from the IPS into the needed traction current supplied in the train feeding system (ORCS).

Auxiliary Substations:
It converts the primary energy coming from the IPS into the needed current to the passengers stations and signalling equipment if applicable.

Redirected Current System:
It contains all the power supply equipment not already included in TPS, IPS, HML, AXS. It can be feeder boxes and isolating switches in line and in depot, specific electrification depot equipment and cables along the tracks (traction cables to supplied the feeding system, positive and negative feeders, LV Cables, control cables, etc.).

Overhead Rigid Catenary System:
It delivers the traction current to the metro trains via its pantograph.
It contains aluminium rail, contact wire, and all type of fittings (cantilevers, rigid portals, headspans, etc.), connections, section insulators, and all catenary equipment.

MAIN FACTS

Alstom developed Rigid Overhead Catenary completing its in house feeding systems offer for electrification in tunnels, stations and bridge passages. Rigid Overhead Catenary is suitable for a wide range of applications, from urban to main-line rail transport.

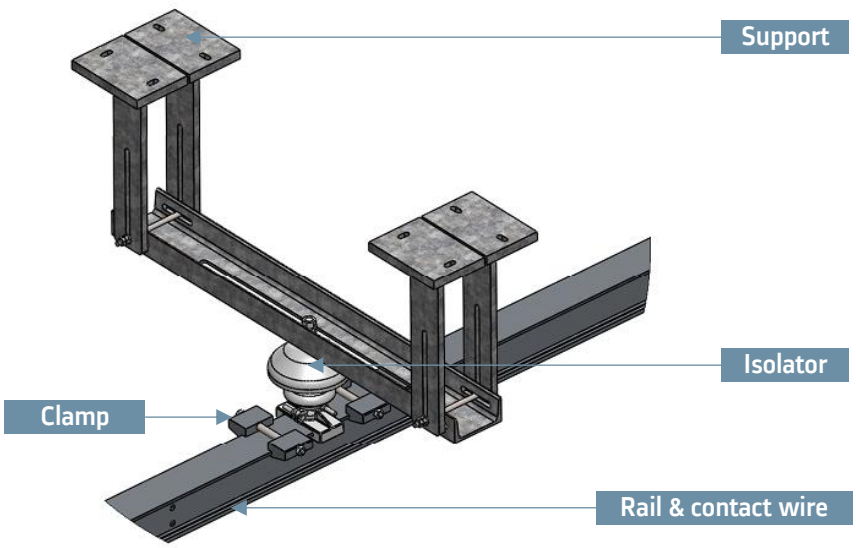
Alstom's Rigid Overhead Catenary solution is a reliable and cost-effective alternative to conventional overhead contact lines in all the cases where space constraints are very stringent. The rigid contact line composed of an aluminium conductor profile with a copper contact wire clamped underneath.
The key benefits of the rigid catenary are mainly related to its small size, lower maintenance costs and higher level of performance RAMS (Reliability, Availability, Maintainability and Safety):

It requires little space for installation, becoming the preferred solution, sometimes indispensable, in the tunnels. The space saving is even greater considering the absence of tensioning devices and parallel feeders.
For depots, the design and installation is much easier thanks to the absence of mechanical tensioning.

It carries high currents (including short circuit currents), thanks to the big* overall section. Generally, the current capability of Rigid Catenary System is about 3500 A (depending on environmental conditions) and it allows very frequent train passages (headways about 2 minutes) without additional feeders.

Compared to the conventional catenary, the contact wire can be exploited more (up to 30% of original section), and it is also less worn thanks to a better contact with the pantograph. In case of replacement, it can also be done on short sections, quickly and safely thanks to the absence of wire tension.

The number of components is reduced up to 80% in respect to a Conventional catenary, which is beneficial for maintenance, warehousing and installation.



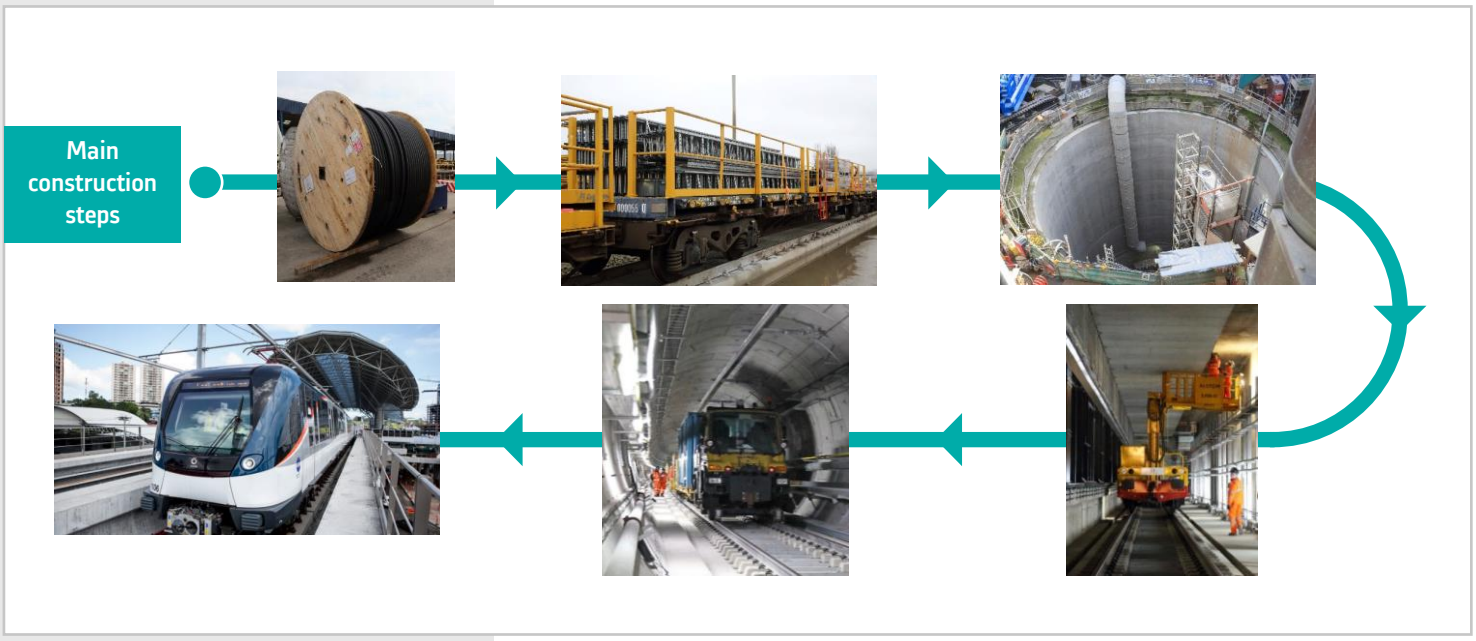
LIFE CYCLE DESCRIPTION

Environmental impacts of Alstom reference solution for Metro electrification has been characterized through the realization of a LCA in accordance with ISO 14040: 2006. EIME software and associated EIME database are used to perform this life cycle impact assessment. Version 2016 of the database has been used.

Function and functional unit

The function of the railway electrification infrastructure is to convert and distribute electricity to a fleet of metro trains.

The functional unit is to provide the electrification function for 1 km of double track metro line, over 20 years of infrastructure service life. In line with foreseen applicative projects for the studied infrastructure, the European geographical area is considered.



Life cycle boundaries

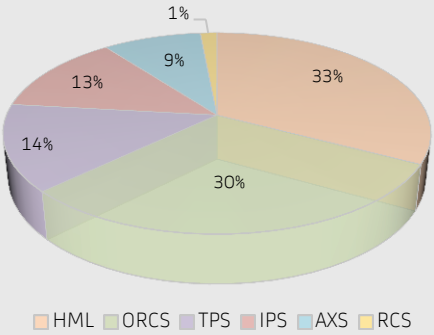
The whole life cycle of the solution is considered, in other words, the LCA is a "cradle to grave" LCA that take into account all life cycle phases form the extraction of raw materials which compose the different equipment to the end of life waste management. Transports along the supply chain and to the construction site are included as well as all construction activities (logistic means, electricity, vehicles and consumable).

The operation of the infrastructure requires a certain amount of energy and maintenance step consists in the cleaning and lubrication of electronic and electrical equipment and the inspection of rigid catenary parts. Finally, deconstruction, collection and treatment end of life materials have been considered.

The European grid mix has been used for the electricity consumption and losses as well as for the energy need during production of parts, construction and maintenance.

LIFE CYCLE DESCRIPTION

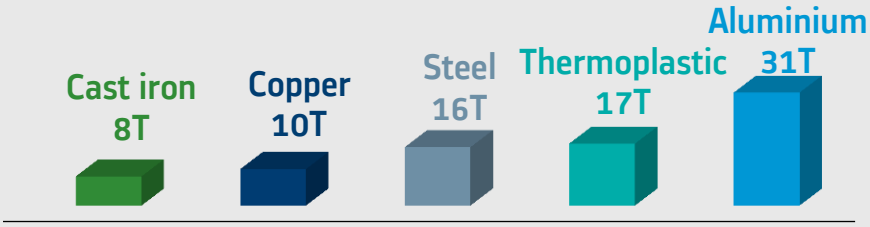
Share of mass by sub-system



Bill of materials

Materials used for the installation of the electrification infrastructure as well as for its maintenance have been inventoried. No replacement of parts is expected for preventive maintenance activities. Total weight associated to the solution is 88 696 kg/km. Top five materials and corresponding quantities per km of electrified line are:

Top five materials (T/km)



95% RECYCLABILITY RATE

98% RECOVERABILITY RATE

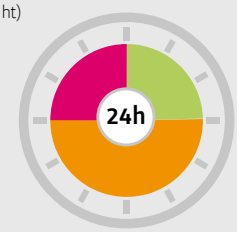
A recyclable solution

The main components of the solution are metallic materials and electronic and electrical equipment which allow a high recyclability potential. Moreover such electrification solution are very likely to be refurbished rather than to be completely dismantled, limiting the quantity of end of life waste generated.

Hazardous substances

No substances meeting the criteria of Substances of very high concern (SVHC) in REACH regulation article 33 have been identified in the solution.

6 h of WITHOUT SERVICE (night)



6 h of "PEAK HOURS" (1 train / 2 min)

12 h of "OFF PEAK HOURS" (1 train / 4 min)

Operation of the infrastructure

Operation of the infrastructure requires a certain amount of energy corresponding to the energy losses along the electrification chain and the energy consumption of auxiliaries feeding equipment inside substations (IPS, TPS). Energy flows considered in this LCA are calculated thanks to Alstom internal simulation tool which incorporates model from existing applicative projects and enable to set a use scenario for one average day of service.

ENVIRONMENTAL PERFORMANCE

Use of resources

FLOW PER FUNCTIONAL UNIT	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
NON-RENEWABLE RESOURCES					
Material resources	**kg**	**2,43E+06**	**5,54E+03**	**3,57E+07**	**3,81E+07**
Inert rock	kg	4,03E+05	7,58E+03	3,53E+07	3,57E+07
Dolomite	kg	1,93E+06	1,05E+00	1,42E+02	1,93E+06
Other	kg	9,10E+04	8,56E+02	3,50E+05	4,42E+05
Energy resources	**MJ**	**6,27E+06**	**1,32E+06**	**1,80E+08**	**1,88E+08**
Uranium	MJ	4,06E+06	2,32E+04	5,71E+07	6,12E+07
Natural gas	MJ	4,29E+04	9,49E+04	4,27E+07	4,28E+07
Hard coal	MJ	1,23E+06	1,89E+04	3,58E+07	3,71E+07
Crude oil	MJ	6,26E+05	1,21E+06	2,22E+07	2,40E+07
Brown coal	MJ	2,83E+05	4,47E+03	2,19E+07	2,22E+07
Peat	MJ	4,51E+03	4,13E+01	3,06E+05	3,10E+05
RENEWABLE RESOURCES					
Material resources					
Soft wood (dry matter)	kg	4,63E-01	6,88E-12	1,95E-10	4,63E-01
Wood, soft, standing	m3	3,07E-02	0,00E+00	0,00E+00	3,07E-02
Wood, primary forest standing	m3	1,20E-06	0,00E+00	0,00E+00	1,20E-06
Energy resources	**MJ**	**2,10E+05**	**3,89E+04**	**2,46E+07**	**2,49E+07**
Hydro power	MJ	1,21E+05	1,98E+03	1,06E+07	1,08E+07
Wind power	MJ	2,50E+04	6,50E+02	6,74E+06	6,76E+06
Solar power	MJ	1,95E+04	3,76E+04	6,69E+06	6,74E+06
Other	MJ	4,22E+04	4,49E+02	5,90E+05	6,33E+05
SECONDARY RESOURCES					
Secondary material	**Kg**	**2,51E+04**	**0,00E+00**	**0,00E+00**	**2,51E+04**
Secondary energy	**MJ**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

Water use

FLOW PER FUNCTIONAL UNIT	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Total water use in the life cycle	**kg**	**4,23E+06**	**3,46E+06**	**3,44E+10**	**3,44E+10**
Direct use in the core process	**kg**	**0**	**0**	**0**	**0**

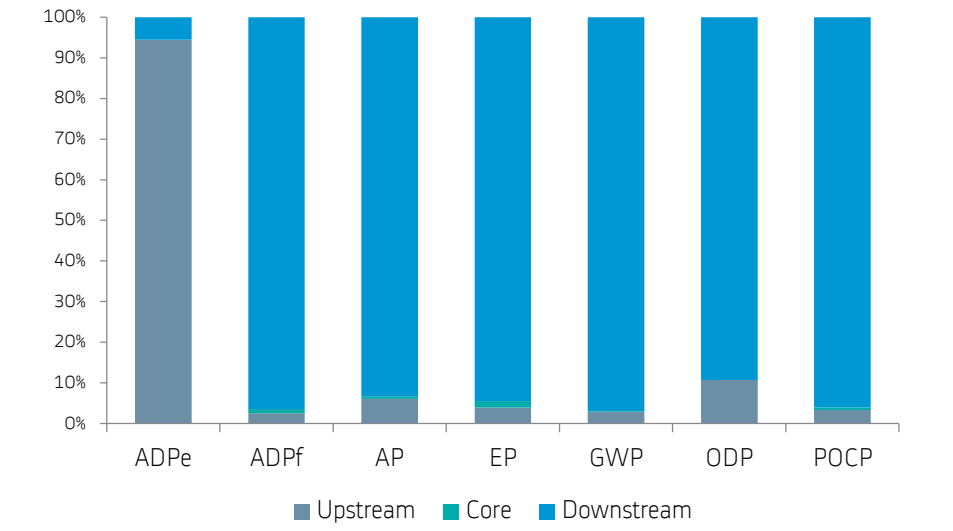
Waste

FLOW PER FUNCTIONAL UNIT	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Non-hazardous waste	**kg**	**4,25E+05**	**5,04E+03**	**3,55E+07**	**3,59E+07**
Hazardous waste	**kg**	**1,12E+06**	**1,61E+02**	**9,67E+03**	**1,13E+06**
Radioactive waste	**kg**	**3,37E+02**	**1,94E+00**	**2,35E+04**	**2,38E+04**

ENVIRONMENTAL PERFORMANCE

Environmental impacts

INDICATOR PER FUNCTIONAL UNIT		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Global warming potential	GWP	kg CO_2e	3,01E+05	1,99E+04	1,00E+07	1,03E+07
Acidification potential	AP	kg SO_2e	2,64E+03	2,71E+02	4,06E+04	4,35E+04
Eutrophication potential	EP	kg PO_4^{3-}e	1,13E+02	4,52E+01	2,68E+03	2,84E+03
Photochemical oxidant creation potential	POCP	kg C_2H_4e	8,26E+01	1,61E+01	2,38E+03	2,48E+03
Emission of ozone-depleting gases	ODP	kg CFC 11e	7,35E-02	1,67E-04	6,10E-01	6,84E-01
Depletion of abiotic resources-elements	ADPe	kg Sbe	2,06E+01	2,02E-02	1,21E+00	2,18E+01
Depletion of abiotic resources-fossil fuels	ADPf	MJ	3,24E+06	1,32E+06	1,23E+08	1,27E+08



Contribution of each phase to the environmental impacts

Configurations

- Life cycle description information and environmental performance results published in this EPD corresponds to the reference design configuration developed by Alstom.
- To know the performance associated to other possible configurations of the solution please contact Alstom.

ENVIRONMENTAL PERFORMANCE

DEFINITIONS

Global warming potential

This indicator calculates the contribution to global warming of the planet by the emission of greenhouse gases.
The result is expressed in kg equivalent CO2.

Acidification potential

This indicator calculates the atmospheric acidification caused by the emission of gas with an acidifying effect.
The result is expressed in kg equivalent SO2

Eutrophication potential

This indicator calculates the eutrophication of water caused by the emission of specific substances (discharge of phosphoric, nitrogenous and organic matter).
The result is expressed in kg equivalent phosphate.

Photochemical oxidant creation potential

The potential for creating tropospheric ozone is caused by the discharge of specific gases which have an oxidizing action under the effect of solar radiation. This indicator calculates the potential for the creation of photochemical ozone from the emission of about a hundred substances.
The result is expressed in kg equivalent ethylene.

Emission of ozone-depleting gases

This indicator calculates the contribution made by the discharge of specific gases responsible for ozone layer depletion.
The result is expressed in kg equivalent CFC-11.

Depletion of abiotic resources-elements

This Indicator calculates the depletion of natural non-fossil resources.
The result is expressed in kg equivalent of Sb.

Depletion of abiotic resources-fossil fuels

This Indicator calculates the depletion of natural fossil resources.
The result is expressed in MJ.

Additional information

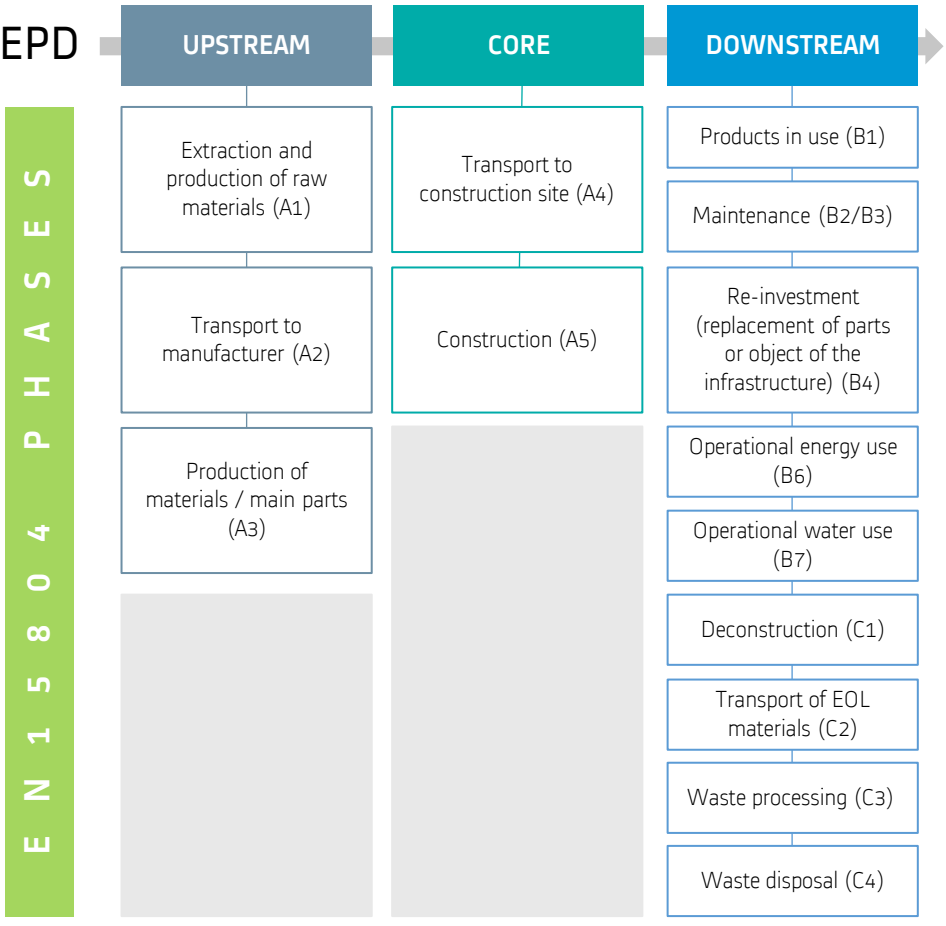
Noise and vibration

Noise is mainly generated by transformers in sub-stations (IPS, TPS, AXS) and rectifiers in traction sub-stations (TPS). Regarding transformers, EN 60076-10 standards limits the noise level to 65 dB(A) at 1 m and at no load. At nominal load, there is no standards limitation but usual noise level reached is about 75 dB(A) at 1 m. There is no existing standardized requirement for rectifier. Usual noise level reached is quite the same than transformer, about 75 dB(A). As a result, it can be expected that noise order of magnitude at sub-station level is about 75 dB(A). For the infrastructure solution studied, sub-stations are buried and thus the noise generated inside the sub-stations is quite attenuated regarding outside potential receptors.

Biodiversity and water management

Impact on biodiversity and water flow should be dealt with, case by case, for each applicative project at global infrastructure level (as part of environmental impact statement if applicable).

Correspondence with EN15804 phases



PROGRAMME RELATED INFORMATION AND VERIFICATION

Product category rules (PCR):
Railways, PCR 2013:19, version 2.01

PCR review was conducted by:
The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com/TC. The PCR review panel may be contacted via info@environdec.com.
Members of the Technical Committee were requested to state any potential conflict of interest with the PCR moderator or PCR committee, and were excused from the review.

Independent verification of the declaration and data, according to ISO 14025:2006:

☐ EPD Process Certification (internal) ☒ EPD Verification (external)

Third party verifier:
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Accredited by:
Recognized individual verifiers, approved by the International EPD System.

EPD®s within the same product category but from different programmes may not be comparable.

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ALSTOM
Designing fluidity

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